(54) Title: QUASI–COAXIAL OPTICAL BAR CODE READER

(57) Abstract

The present invention provides an inexpensive scanner that can scan at near to medium focal lengths. A light beam is generated to illuminate a target area on the scanned object. A mirrored surface (701) directs the light beam towards the object and light reflected from the object to a detector (702). The detector is positioned to receive a constant amount of reflected light from the mirrored surface.

QUASI-COAXIAL OPTICAL BAR CODE READER

BACKGROUND OF THE INVENTION

Field of the Invention

This invention generally relates to scanners using light to read coded

5   symbologies of varying reflectivity. More particularly, the invention pertains to

scanners having rotating mirror wheels in the path of the laser light used to detect and

read coded symbologies. Most particularly, the invention pertains to laser scanners

having simplified optics for emitting and collecting the light used to read coded

symbologies in near to medium focal ranges.

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Description of the Prior Art

Coded symbologies, such as bar coded symbols, are well known. Coded

symbols generally use light and dark areas of varying size in specified combinations.

Each unique combination of light and dark areas represents encoded information.

15   Coded symbology scanners read the code by passing a beam of light over it,

collecting information in the form of light reflected back from the code, and decoding

the collected information.

Prior art bar code scanners can be divided into two main categories, coaxial

and non-coaxial. U.S. Patent No. 5,028,772 is an example of a coaxial bar code

reader. In this patent, a laser emits a beam of light which ultimately passes through an apertured mirror to a facet on a rotating polygon. The beam reflects off the facet through a second series of mirrors and towards a target surface. The light beam reflects off the target surface as diffused light. The diffused light passes back through the second series of mirrors towards a facet. The diffused light reflects off the facet towards the apertured mirror. All of the reflected light, except that which passes through the aperture, is directed towards a lens which focuses it onto a photo detector. Since the emitted light beam and the returned light follow the same path or axis, this scanner is referred to as coaxial. Coaxial scanners are particularly useful in reading surfaces at long focal lengths. During manufacture, coaxial scanners require testing and fine tuning to insure proper alignment of the laser, mirrors, polygon, lens and detector.

U.S. Patent No. 5,262,628 is an example of a non-coaxial bar code reader. A laser emits a beam of light which is guided by a mirror towards a facet on a rotating polygon. The beam reflects off the facet towards the object. Upon striking the object, diffused light reflects off the surface. A detector is positioned at the front of the scanner to collect the diffused light. In this scanner, the emitted light beam and the detected light follow two distinct paths or axis. One axis is through the polygon to the surface. The other is from the surface directly to the detector. There is no

attempt or means for focusing the diffused light on the detector. This scanner is referred to as non-coaxial.

Another example of a non-coaxial scanner is U.S. Patent No. 3,813,140. The laser emits a beam of light directly towards a facet of the polygon. The beam reflects off the facet towards the target. The light reflected from the target is diffused and returns along a different axis to another facet of the polygon. This facet directs the diffused light towards a mirror. The mirror guides the diffused light towards a detector.

U.S. Patent No. 4,115,703 is another example of non-coaxial scanner. The laser emits a beam of light directly at the surface to be scanned. The light reflects off the surface and passes through an aperture in the scanner located directly above the target area. The returned light passes through a lens barrel to a photo detector. To read a code, the scanner must be manually moved across the entire code. Non-coaxial scanners are inexpensive and effective at short focal lengths. At longer focal lengths, non-coaxial scanners are not as effective due to ambient light reaching the detector.

There exists a need for an inexpensive scanner that can scan at near to medium focal lengths of up to two feet from the target area.

SUMMARY OF THE INVENTION

The present invention provides an inexpensive scanner that can scan at near to medium focal lengths. A light beam is generated to illuminate a target area on the scanned object. A mirrored surface directs the light beam towards the object and light reflected from the object to a detector. The detector is positioned to receive a constant amount of reflected light from the mirrored surface.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an isometric view of the elements of the present invention without all of the details of the scanner.

Figure 2 is a top view diagram illustrating the light paths of the present invention to and from a target area.

Figure 3 is a side view diagram illustrating the light paths of the invention to and from a target area.

Figure 4 illustrates the light paths between the laser diode assembly, detector and a facet.

Figure 5 illustrates the light paths between a facet and the scanned object.

Figure 6 illustrates the areas of the facet struck by the light traveling to the object and the light traveling to the detector.

Figure 7 illustrates the location of the detector's collecting surface in relation

to the returned light when the polygon is returning the maximum amount of light.

Figure 8 illustrates the location of the collecting surface in relation for an

intermediate amount of returned light.

5   Figure 9 illustrates the location of the collecting surface in relation to the

minimum amount of returned light.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiments will be described with reference to the drawn

10   figures wherein like numerals represent like elements throughout. Scanner elements,

such as chips, wiring, fasteners and brackets not necessary to discuss the features of

the present invention are not illustrated as they will be known to those skilled in the

art.

As illustrated in **Figure 1,** the present invention has a laser diode assembly

15   101, such as Laser Diode Rohm RLD-65PC, a rotating polygon 102 with facets 105,

106, 107, 108, 109, 110, a filter 103, such as Spectro-Film B-34913, and a photo

detector 104, such as PIN Photo Diode EG&G VTP4085.

As shown in the top view of **Figure 2,** the laser assembly 101 emits a beam

of light 202 towards the polygon 102. The beam 202 is reflected off the facet 105 of

20   the polygon 102 toward the coded symbology 201. The beam 202 strikes the target

201 and is reflected as the diffused light 203. The diffused light 203 impinging on

the facet 105 is reflected toward the filter 103 and the detector 104. The filter 103

only allows light which has the same wavelength as the emitted light beam 202 to

pass through to the detector 104. Using the preferred components, the emitted light

5   beam 202 has a wavelength of 655 nanometers and the filter 103 passes light within

a 40 nanometer bandwidth centered around 660 nanometers. The reflected, diffused

light 203 is collected by detector 104 and subsequently processed in a known manner

and decoded.

Figure 3 is a side view of the present invention in a preferred arrangement.

10   In this embodiment, the laser diode assembly 101 is located directly above the

detector 104. In this view, it can be seen that the polygon height is increased over

that of the prior art as indicated by dashed line 204 so that the laser diode assembly

101 and the detector 104 are pointed in the same direction but not on a common

horizontal center. As a result, the laser beam 202 strikes the facet 105 towards the

15   top. The diffused returning light 203 strikes the entire surface of the facet 105.

While all of the diffused light is directed back in the direction of the filter 103 and

detector 104, the detector 104 only collects the reflected light 203 that impinges on

its surface area. Under the present arrangement, the polygon 102 allows the laser

beam 202 to be centered about one axis and the detector 104 to be about another axis

so that the diffused light 203 reflected on the detector 104 is not co-axial with the beam.

Typically, coaxial scanners focus all of the diffused light 203 from facet 105 on the detector 104, and non-coaxial scanners do not use a facet or focus return light on the detector 104. In the present invention, the height of the polygon has been increased to avoid reflection of the laser beam 202 on the detector 104, and to eliminate the need for a focusing mirror in the return path. When viewed from above as in **Figure 2**, the diffused light 203 encompasses the axis of the emitted light beam 202. As shown in **Figures 4 and 5**, the emitted beam 202, between the laser diode assembly 101 and the facet 105, is on a given centerline or emission path and the reflected light's centerline 401 is returning at an incident angle α based on its reflection from the object's surface 201. The return light 203 available to detector 104 strikes the facet 105 at a position 602 which is separate from and spaced from the beam's position 601 as shown in **Figure 6**. Accordingly, the reflected light will be directed toward the detector 104 along a centerline 401 that is spaced from the centerline of beam 202. Since the emitted light beam 202 and the diffused light 203 travel similar but separate paths, the present invention may be termed quasi-coaxial.

When the facet 105 of the present embodiment is rotated during a sweep, the cross-section of the facet 105 facing the detector 104 varies. As a result, the area of light reflected toward the detector 104 varies. Because there is no means for focusing

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the returning diffused light 203 on the detector 104, the reflected diffused light varies

in position relative to the detector 104.

Figures 7, 8 and 9 show this variance in relation to the light collecting surface

702 of the stationary detector 104. Figure 7 shows the area 701 of returned light

when the polygon is rotated to return a maximum amount of diffused light. Figure

8 shows the area 801, when the polygon is rotated to return an intermediate amount

of diffused light. Figure 9 shows the area 901, when the polygon is rotated to return

a minimum amount of diffused light. As illustrated in these figures, there exists

within each area an area 703 of returned diffused light 203 that will be constant

regardless of the position of the polygon 102. In the present invention, the detector

104 is sized to have a collecting surface area 702 that is within the constant area 703.

The detector 104 is then located at a distance from the rotating surface so that it will

be at the confluence of the areas 703 regardless of the polygon's position. With this

sizing and positioning, the collecting surface 702 will be in an area flooded by

returned light and will be one hundred percent (100%) impinged by returned light.

As a result, the detector 104 reacts as if it was seeing one hundred percent (100%) of

the returned light at all times. Although allowing much of the returned light to pass

by the detector's impingement surface 702 may seem inefficient, it has desirable

properties. This construction avoids the need for apertured mirrors, in the path of the

emitted light, to focus reflected light on the detector. This construction also takes

advantage of the total impingement at all angles to avoid the need for precise location

of the major components relative to each other. Additionally, the preferred filter 103 only allows light with an angle of incidence within a range centered about the mirror to the filter's surface to pass. The construction of the present invention returns the reflected diffused light at such an angle.

5   The present invention has been found to read codes up to two feet from the scanner, but the preferred range is within one foot from the scanner. In addition to its desirability for inexpensive fabrication, this simplified design minimizes testing and adjusting during manufacture and the need for field adjustments.

*   *   *

CLAIMS

1. A scanner of the type having means for generating a light for illuminating a target area on an object, a detector for receiving light reflected from the object and a mirrored surface that directs the illuminating light towards the object and directs reflected light towards the detector, the scanner characterized by:

5   the detector being positioned to receive a constant amount of reflected light from the mirrored surface, said constant amount being less than all of the reflected light from the mirrored surface.

2. The scanner of claim 1 wherein the mirrored surface directs varying amounts of reflected light between known maximum and minimum amounts, towards the detector and the constant amount of reflected light received by the detector is no greater than the minimum amount of reflected light.

3. A scanner of the type having means for generating a light for illuminating a target area on an object, a detector for receiving light reflected from the object and a mirrored surface that directs the illuminating light towards the object and directs reflected light towards the detector, the scanner characterized by: the illuminating

5   light striking the mirror in a first area and reflected light to be made available to the detector striking the mirror in a second area, the first and second areas being separate and not coincident.
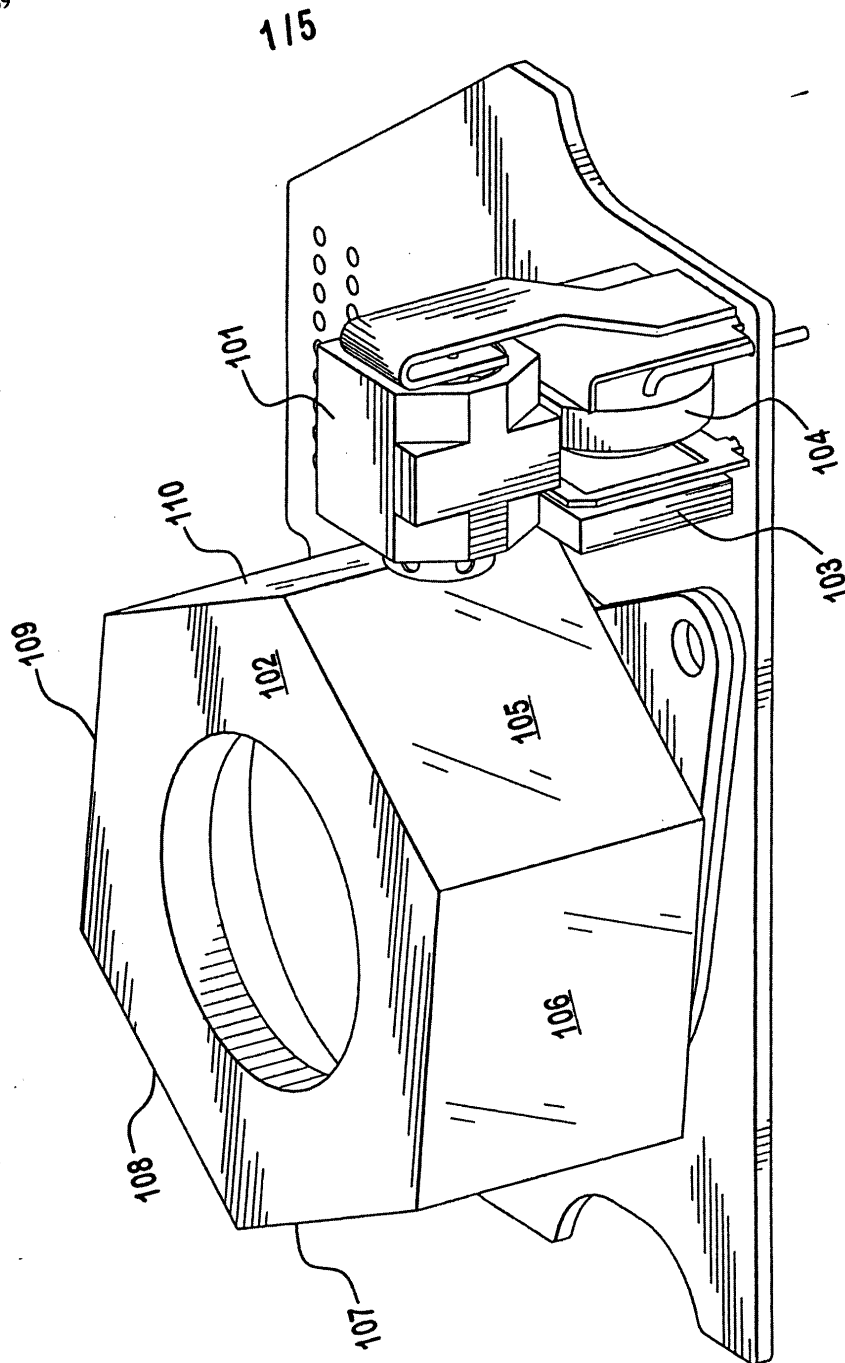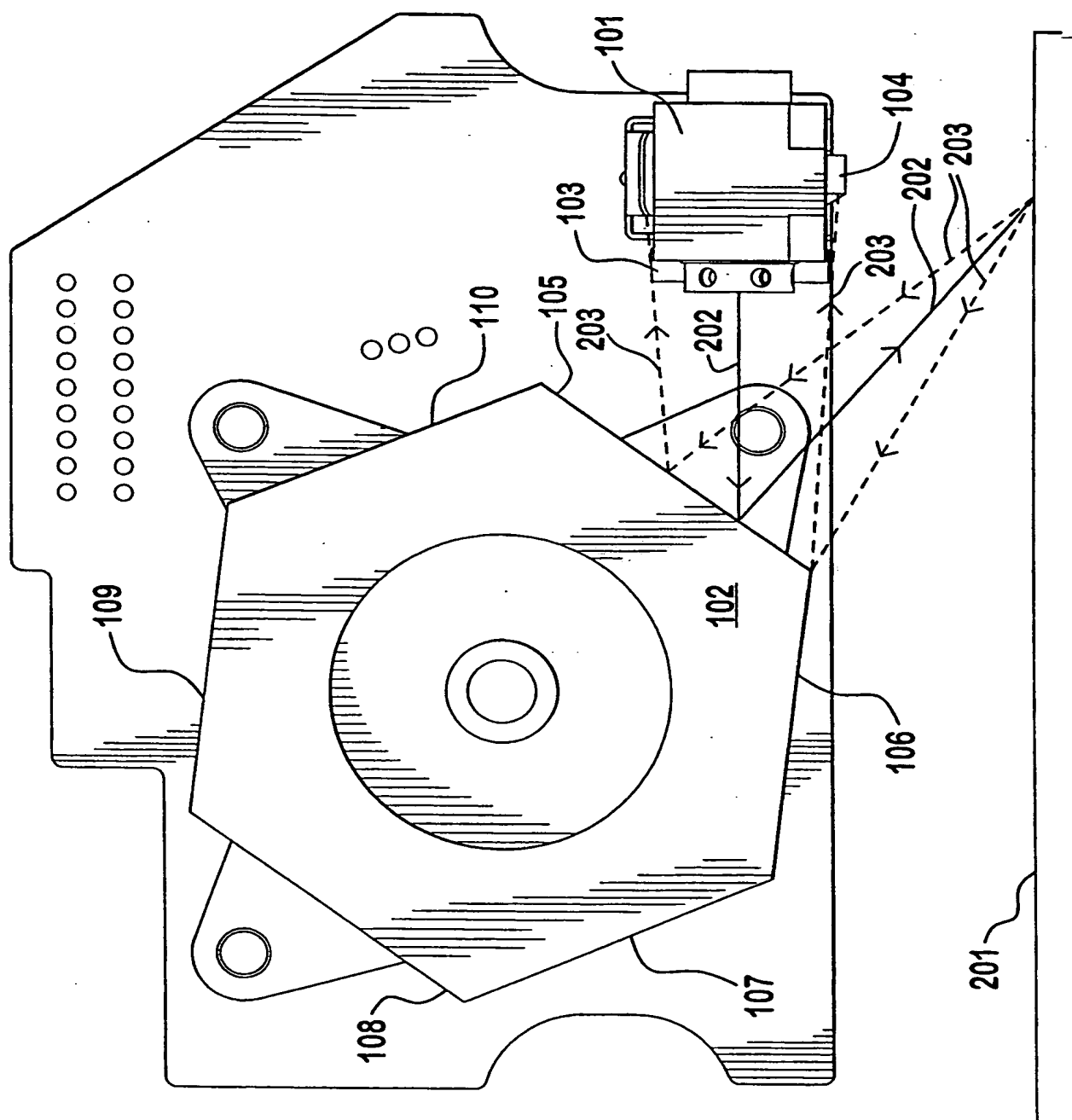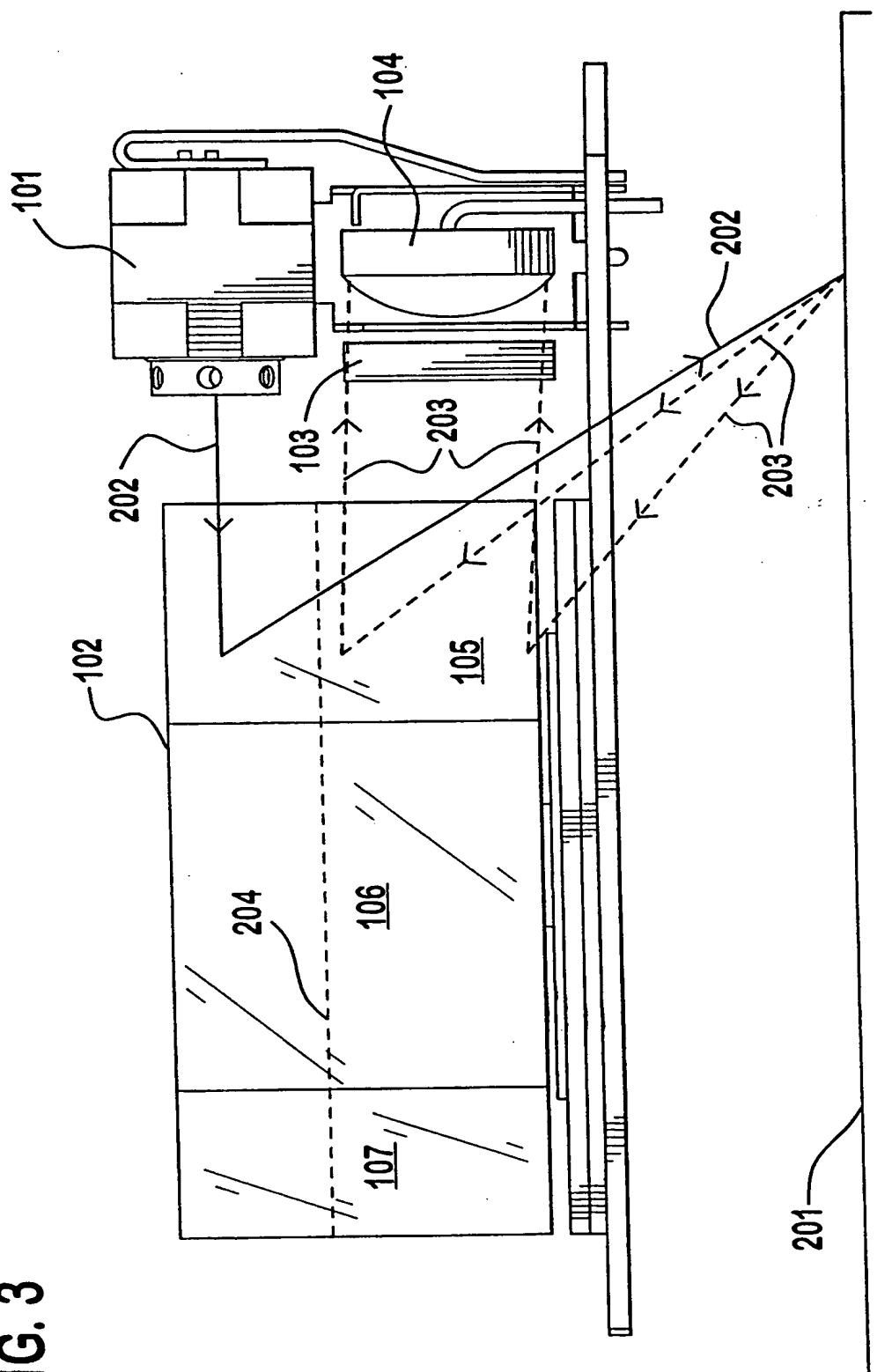
FIG. 1
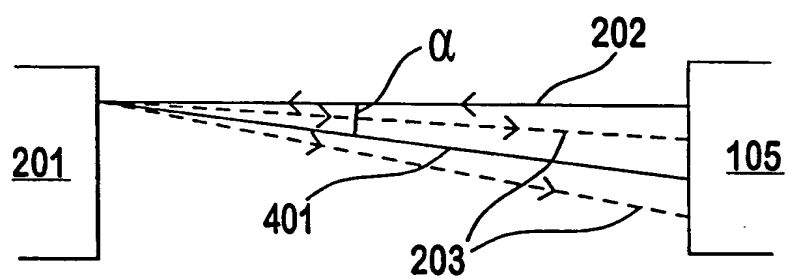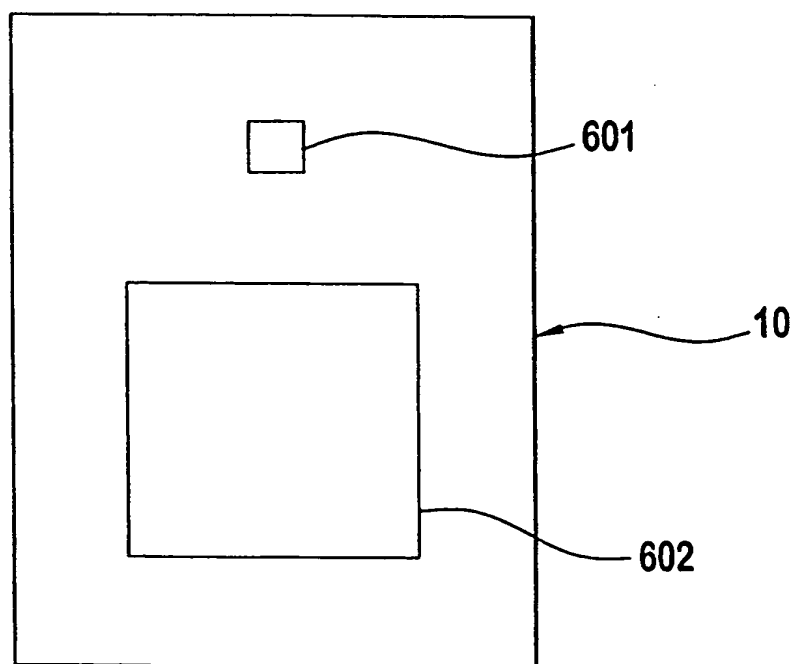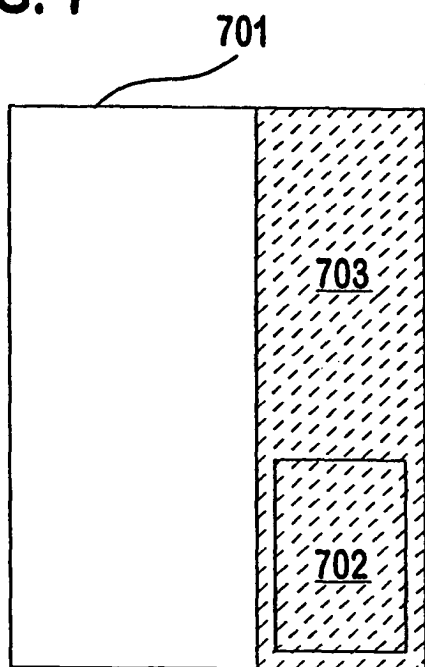
FIG. 2

FIG. 3

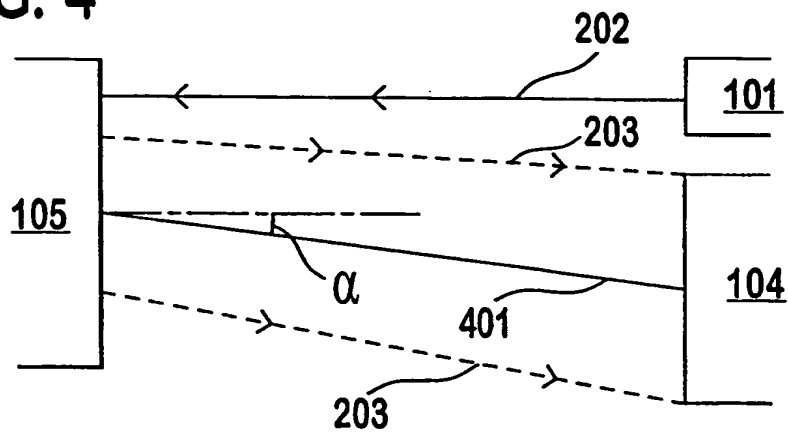## FIG. 4

FIG. 5

FIG. 6

FIG. 7

701

703

702

FIG. 8

801

703

702

FIG. 9

901

703

702
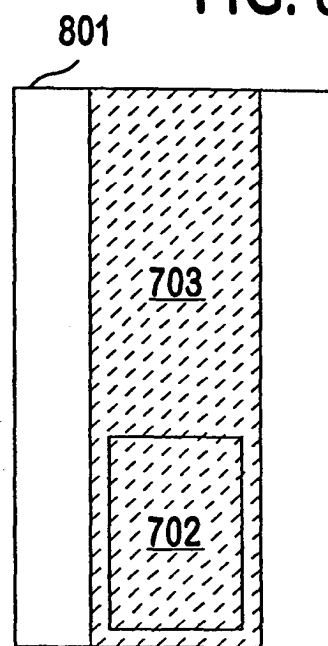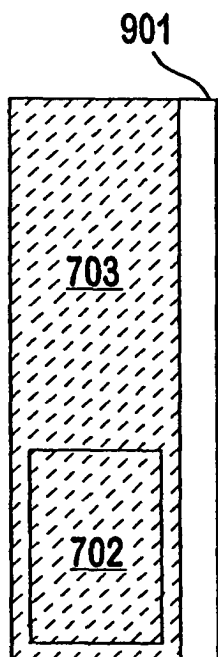
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7   G06K7/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7   G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 833 273 A (OKI ELECTRIC IND CO LTD) 1 April 1998 (1998-04-01) column 4, line 15 -column 5, line 27; claims 1,2; figures 1-3	1-3
X	US 4 461 534 A (RUNCIMAN HERBERT M) 24 July 1984 (1984-07-24) the whole document	1-3

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 December 1999	11/01/2000

Name and mailing address of the ISA	Authorized officer
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